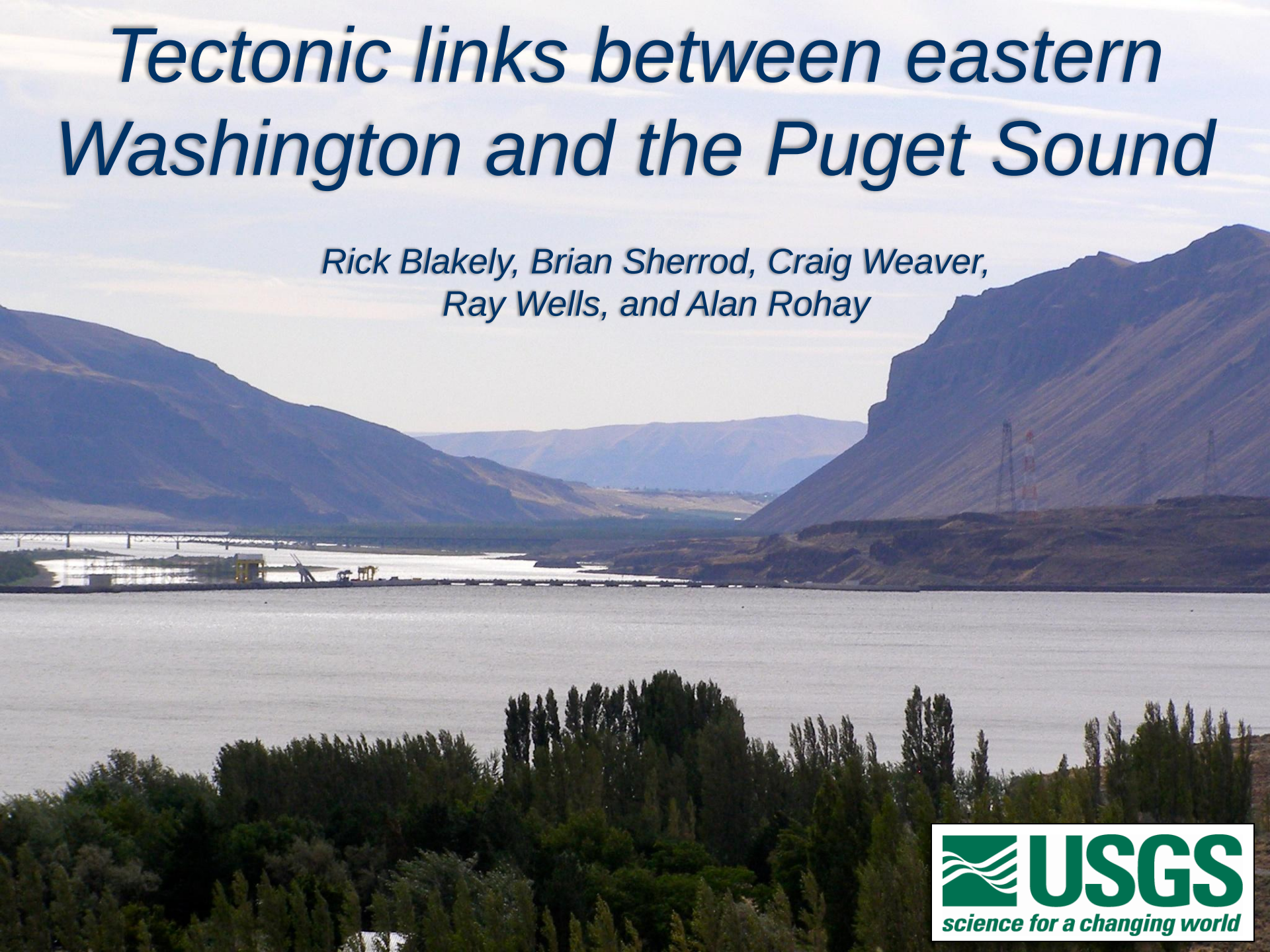
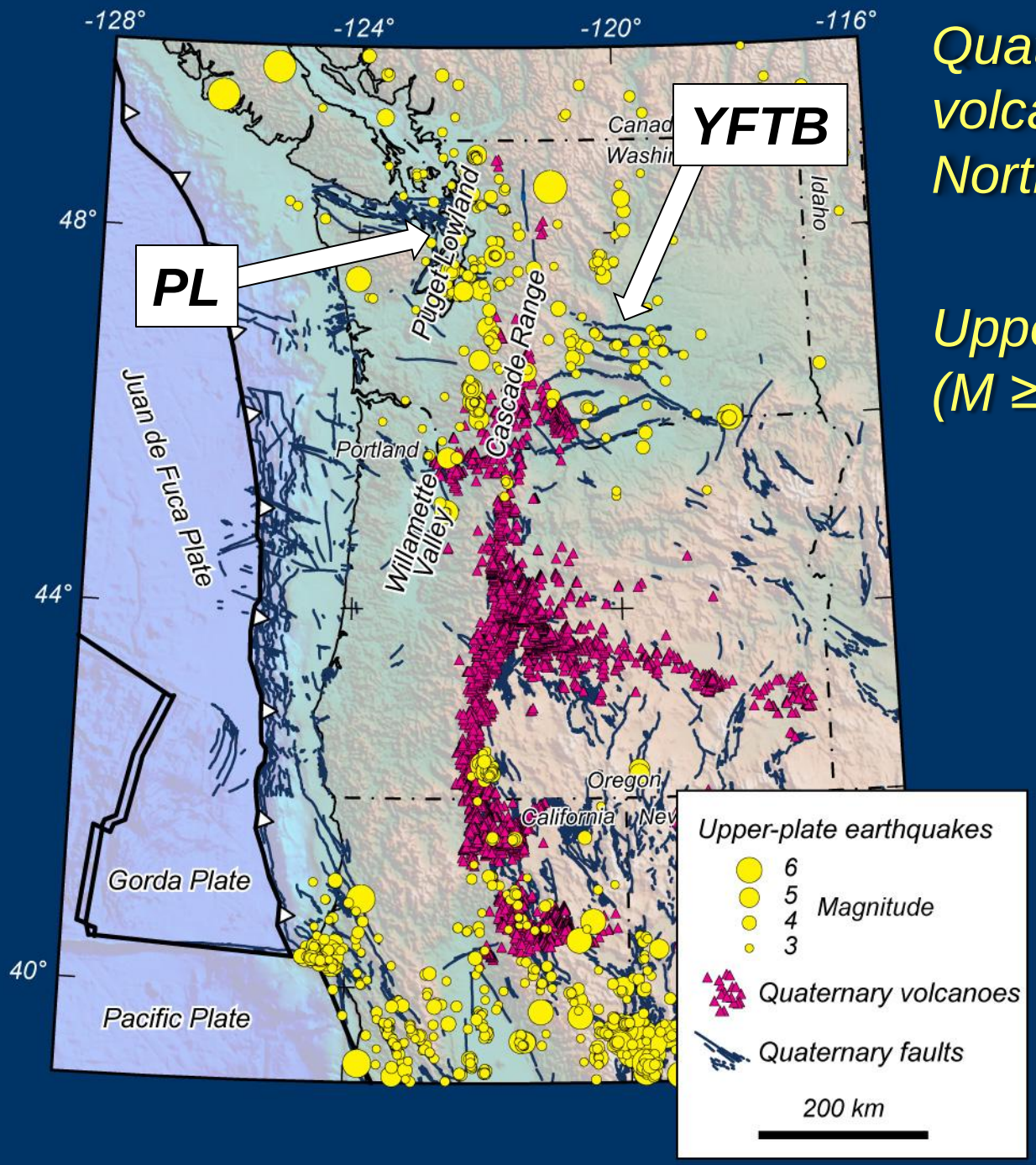
Tectonic links between eastern Washington and the Puget Sound

Rick Blakely, Brian Sherrod, Craig Weaver, Ray Wells, and Alan Rohay

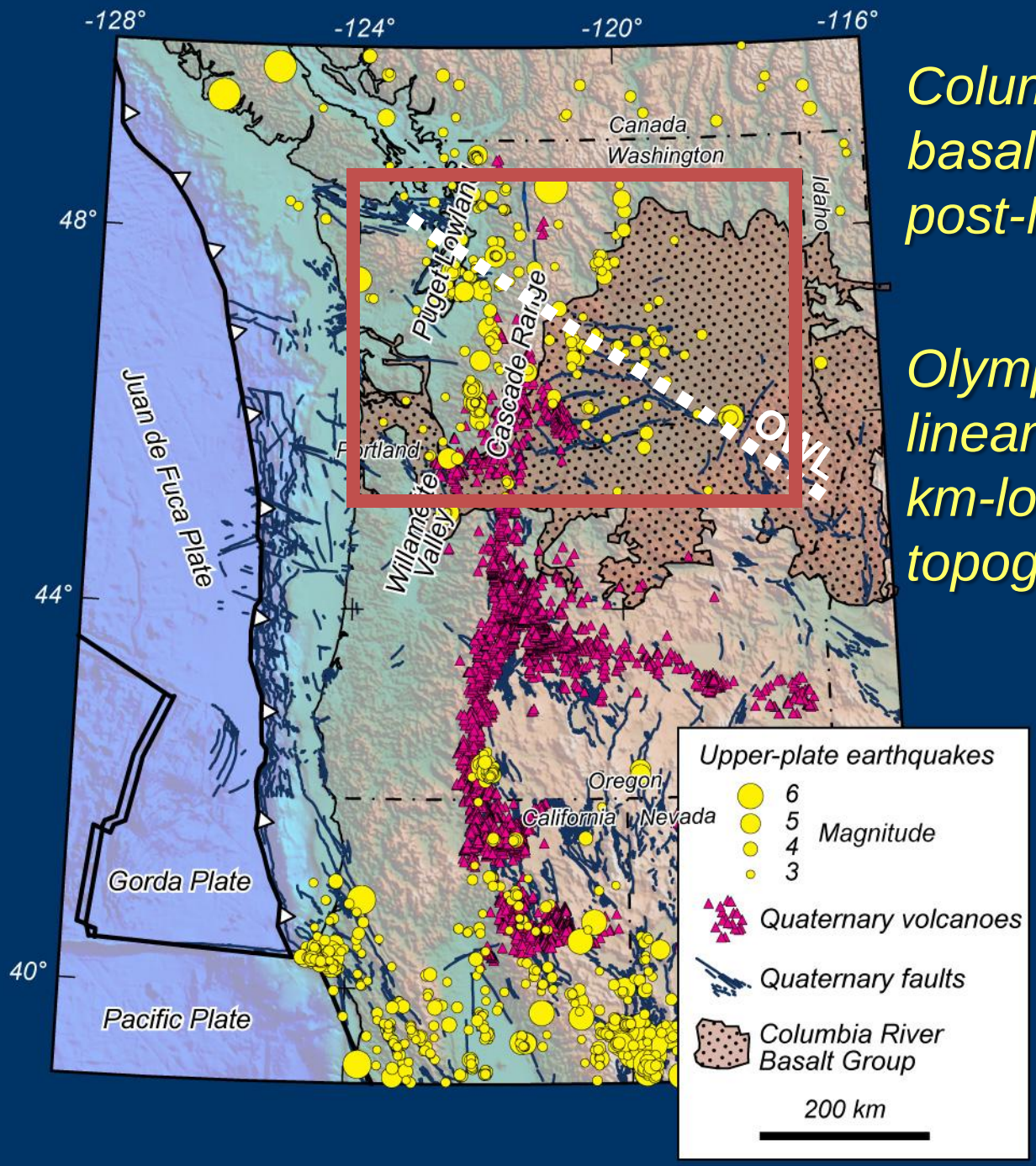


USGS
science for a changing world



Quaternary faults and volcanoes of the Pacific Northwest

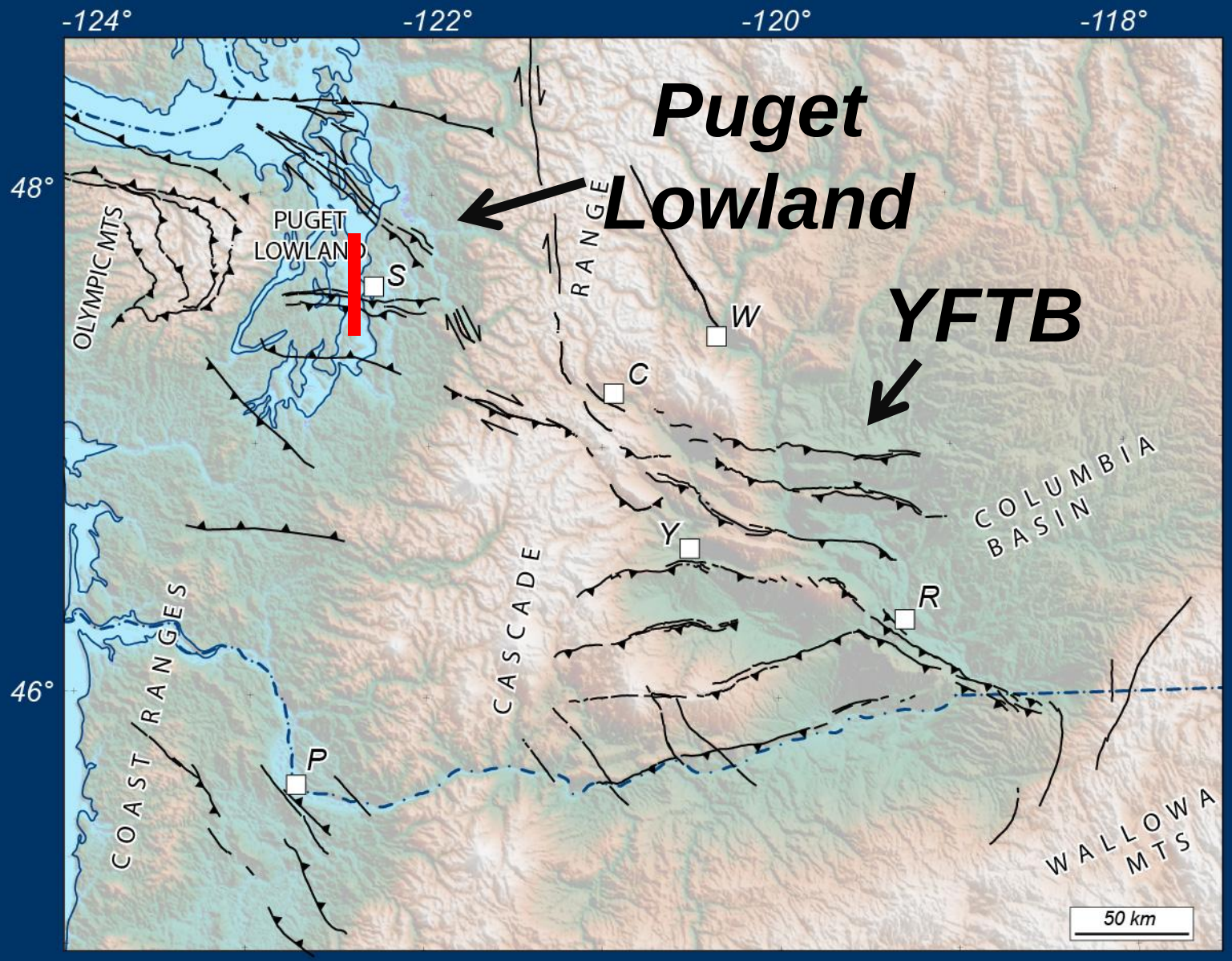
Upper-plate earthquakes (M ≥ 3)



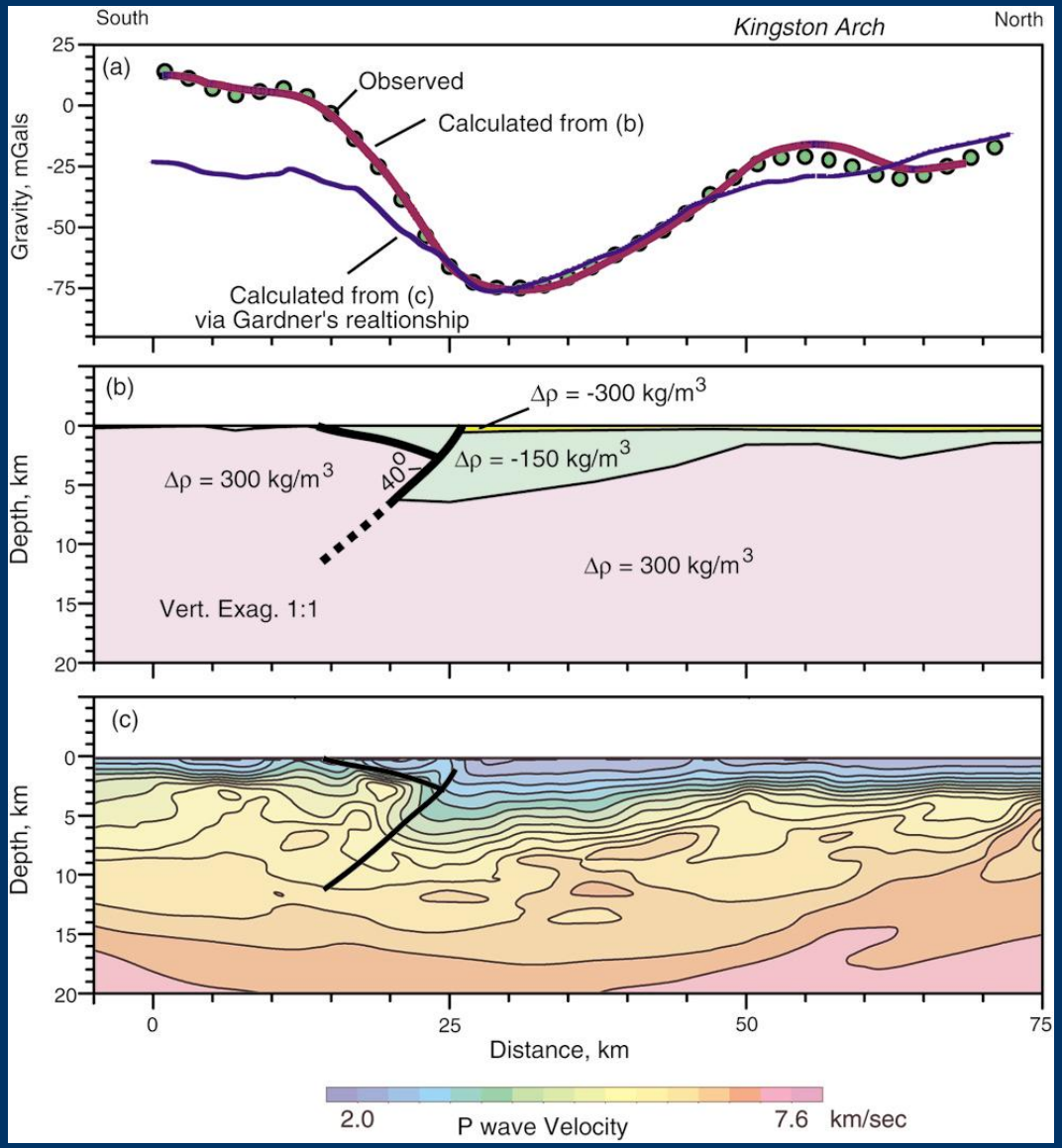
Columbia River flood basalts: a "marker" for post-Miocene deformation

Olympic Wallowa lineament (OWL): a 500-km-long alignment of topography and structure

Faults of Washington and N. Oregon



Seattle fault



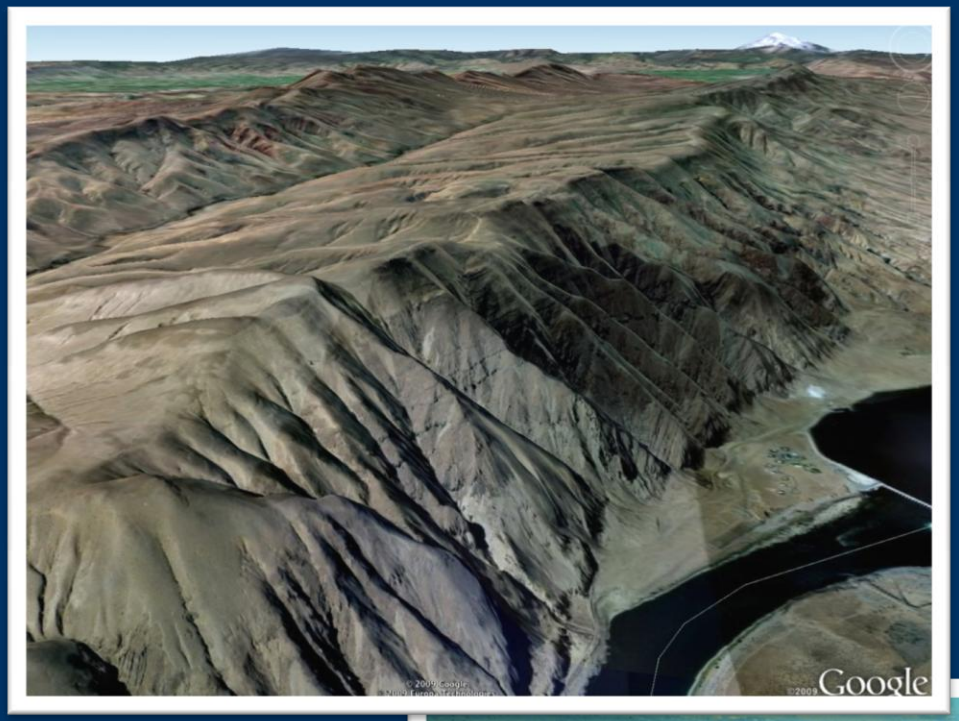
Gravity anomaly

Model and interpretation

Seismic velocity

ten Brink et al. (2002)

YFTB – a backarc fold and thrust belt normal to the margin



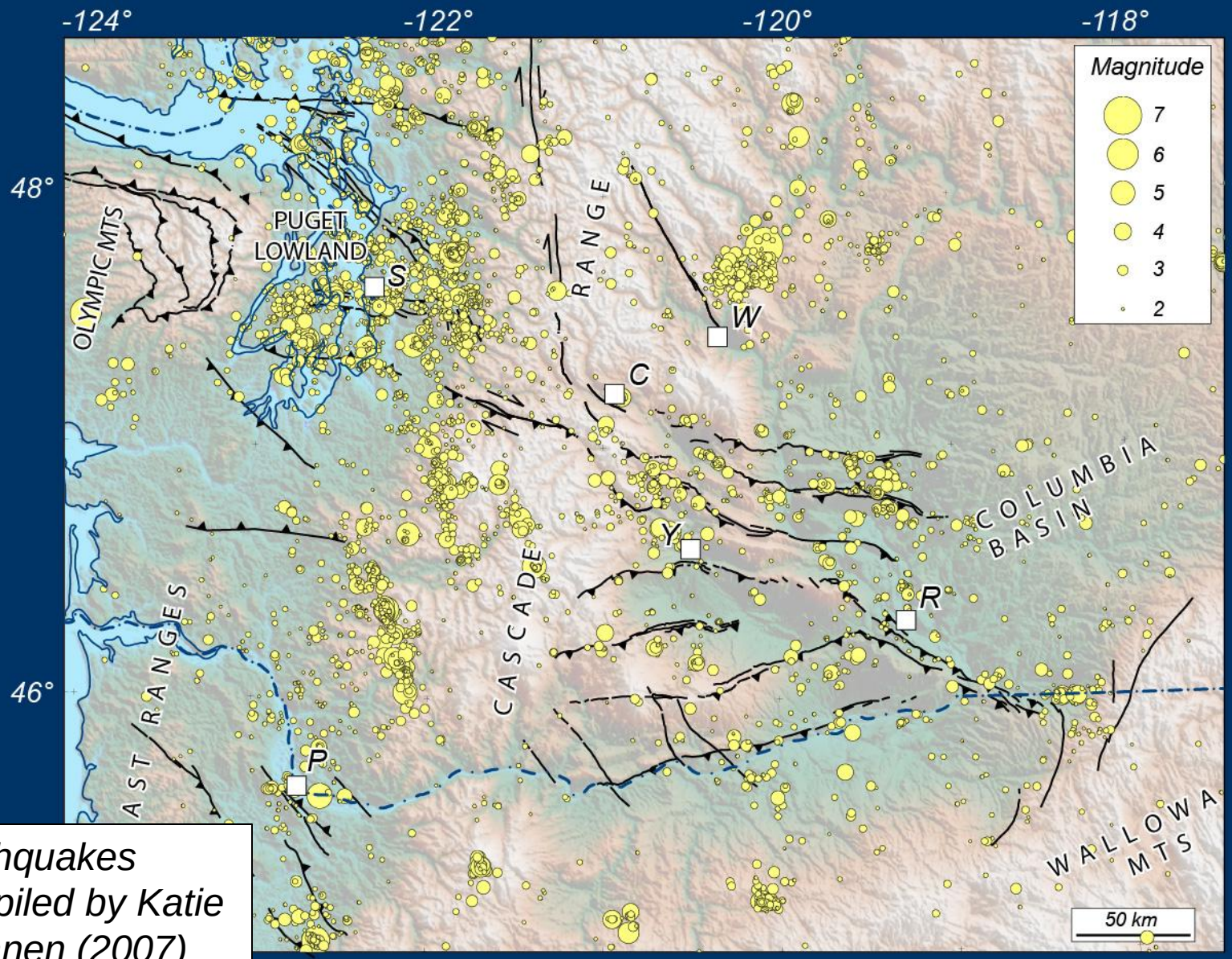
Umtanum Ridge looking W

- *Folds are commonly asymmetric*
- *North verging*
- *Broad, south dipping back limbs*
- *Short, steep, fore limbs.*

Rattlesnake Mt. looking NW

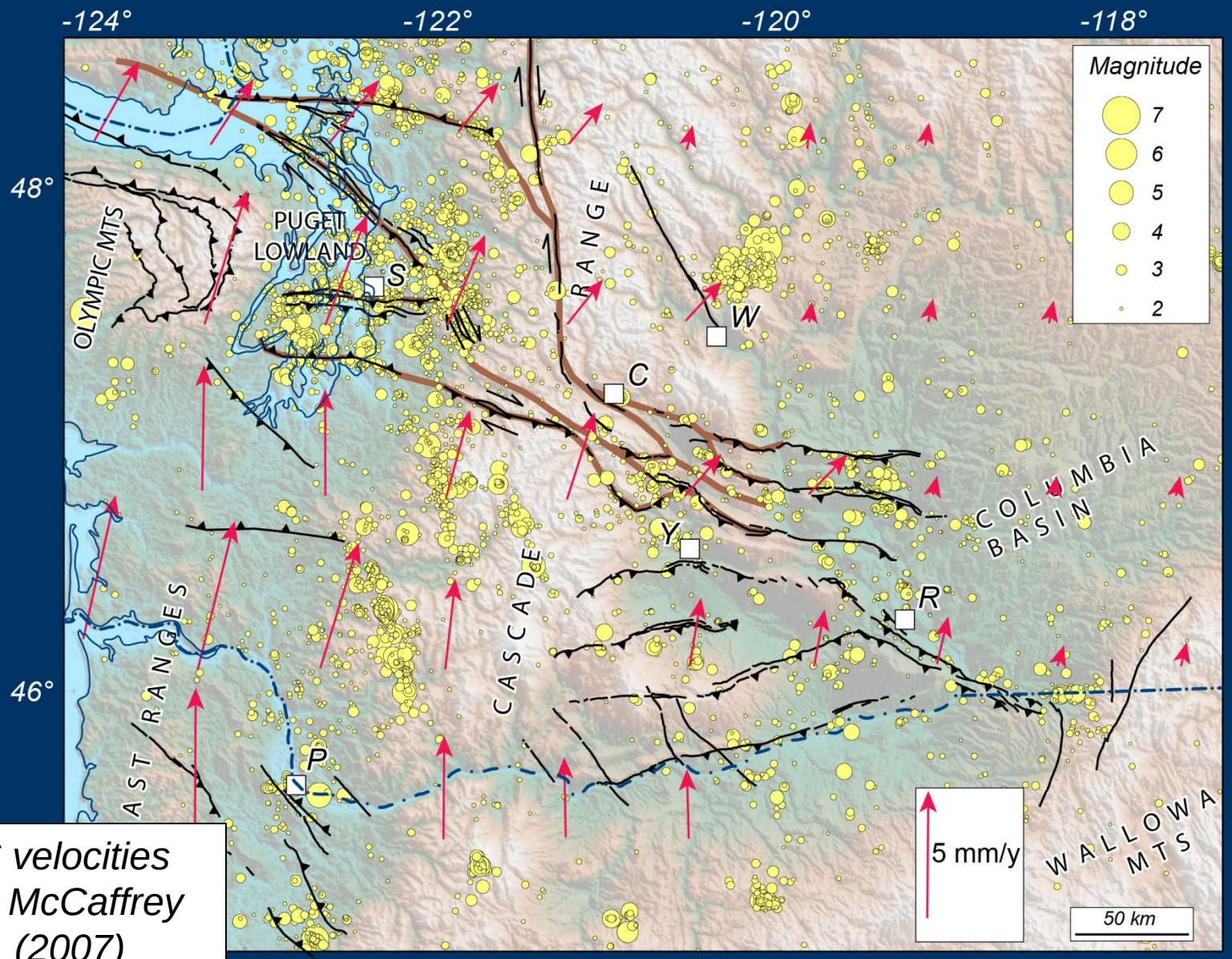
Steve Reidel with Umtanum Ridge x-section of Price and Watkinson

Recent Earthquakes of Washington and N. Oregon



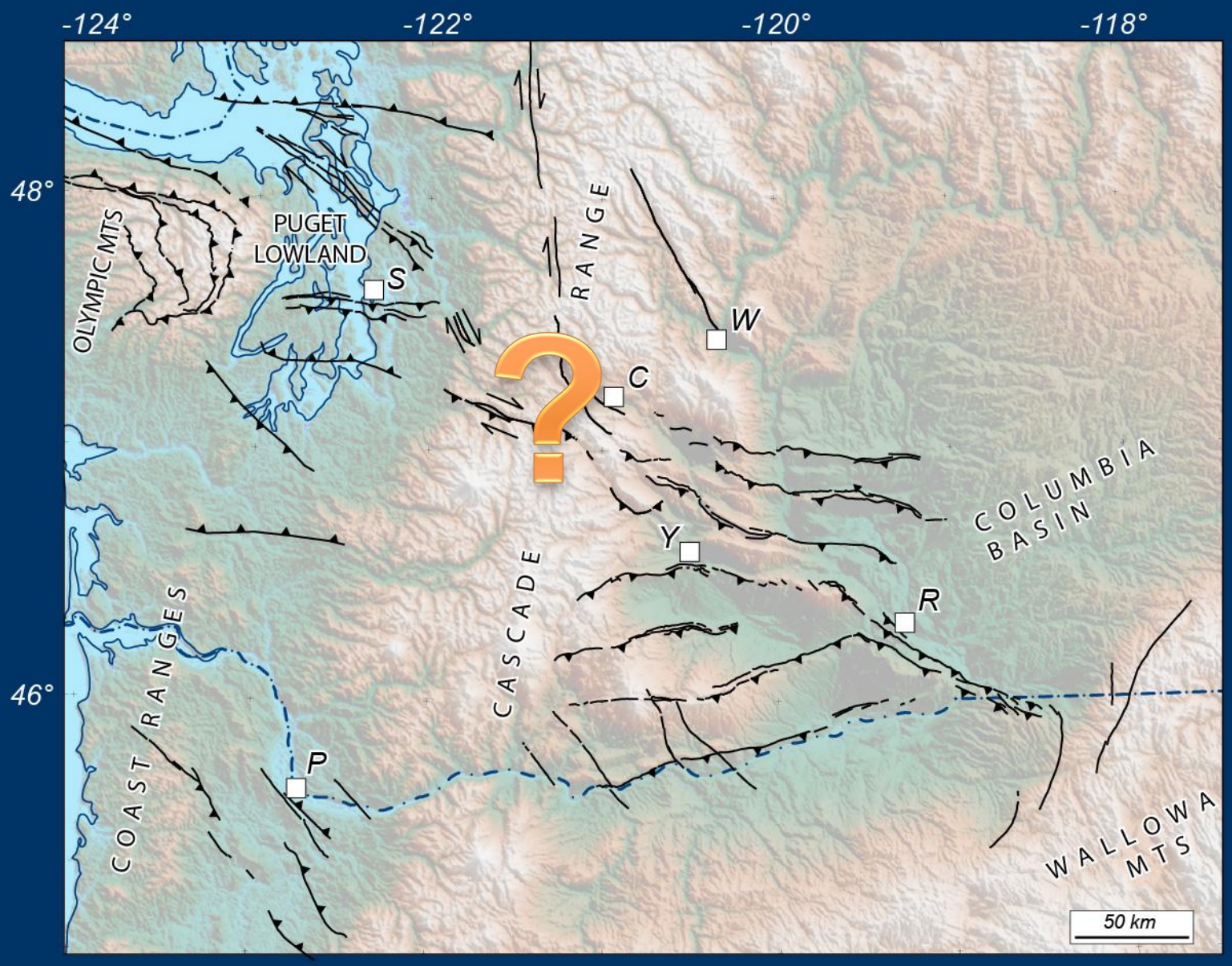
Earthquakes compiled by Katie Keranen (2007)

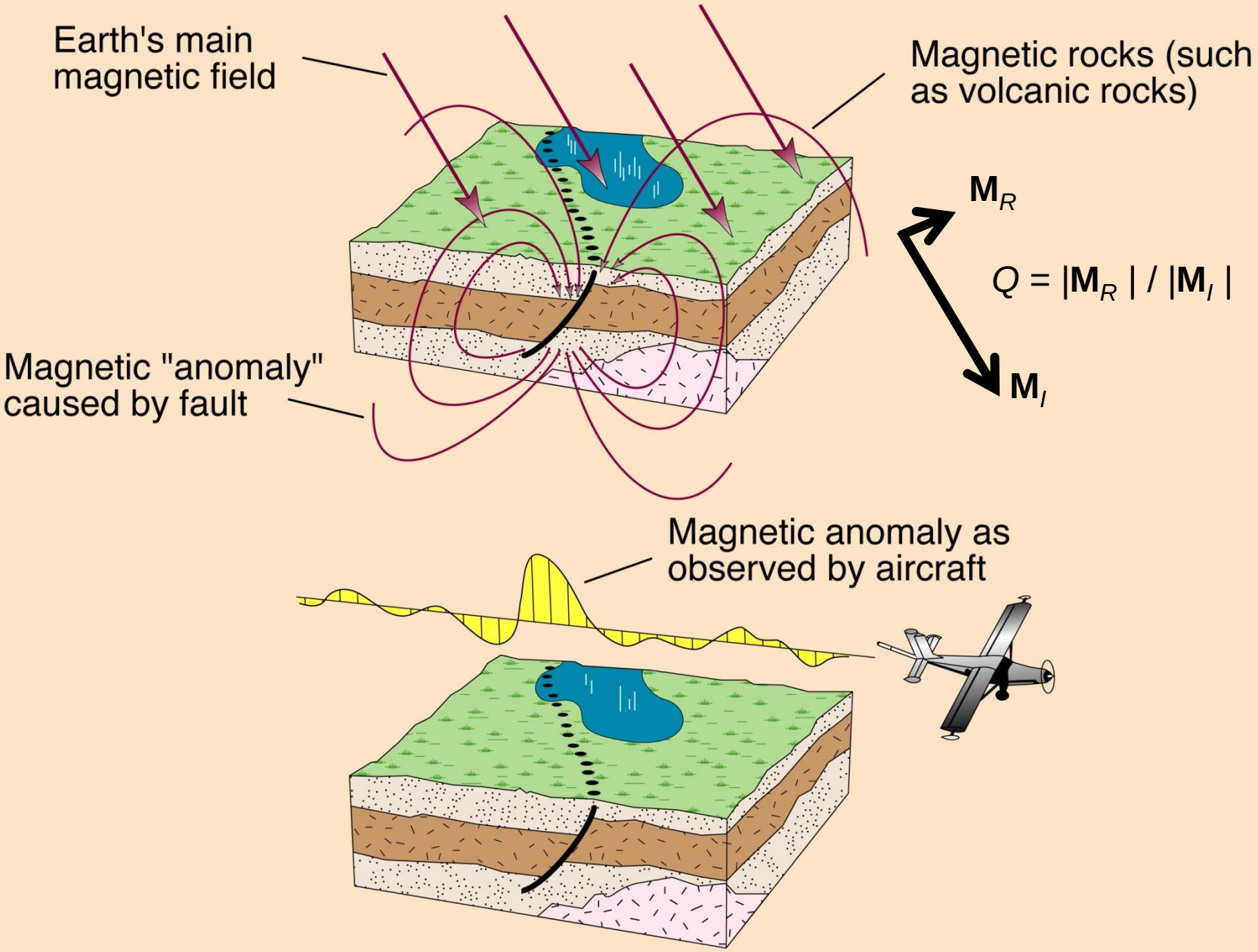
Horizontal Velocity from GPS Measurements



GPS velocities from McCaffrey et al. (2007)

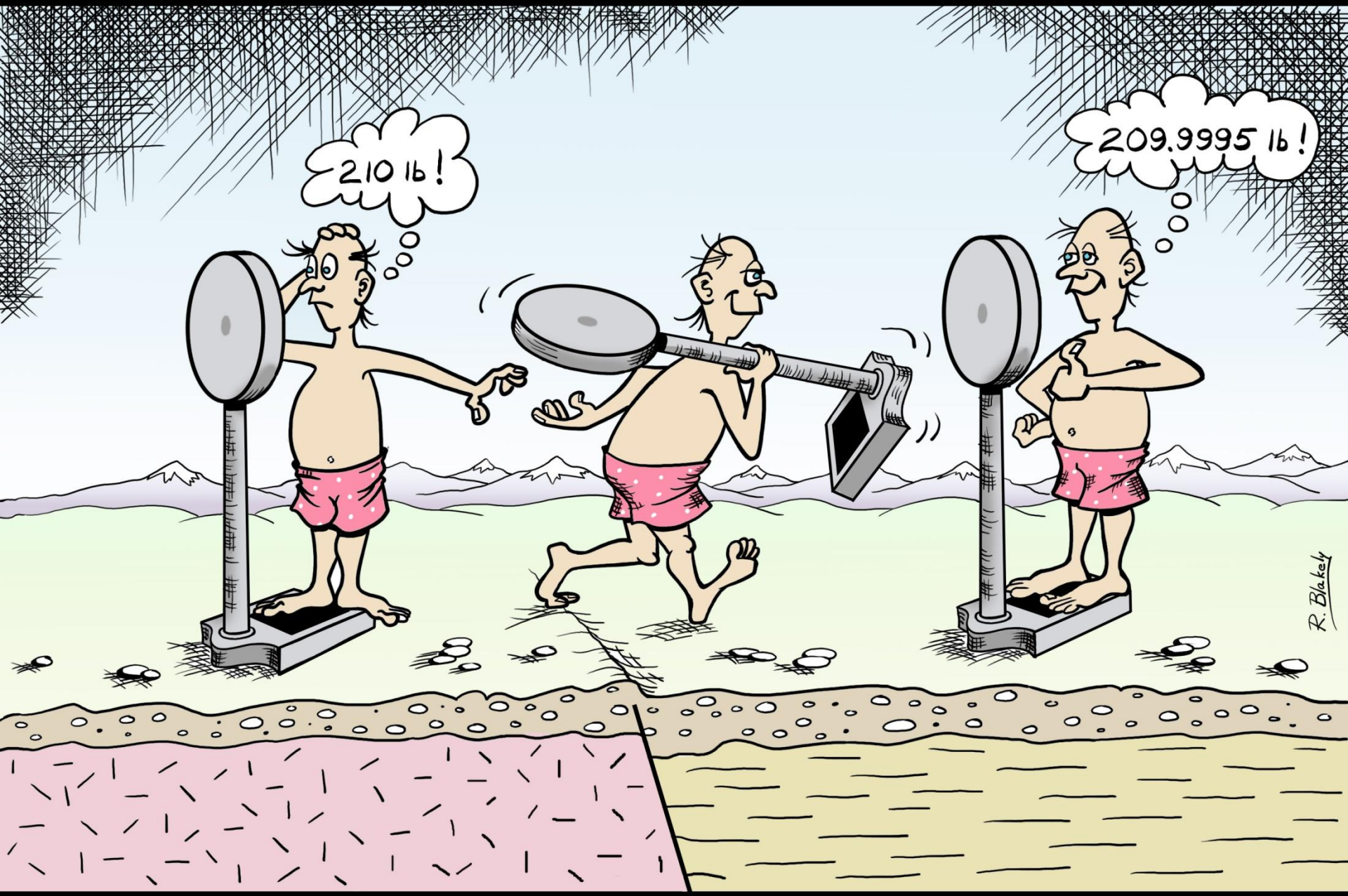
Faults of Washington and N. Oregon




Earth's main magnetic field
Magnetic rocks (such as volcanic rocks)
$\mathbf{M}_R$
$Q = |\mathbf{M}_R| / |\mathbf{M}_I|$
$\mathbf{M}_I$
Magnetic "anomaly" caused by fault
Magnetic anomaly as observed by aircraft

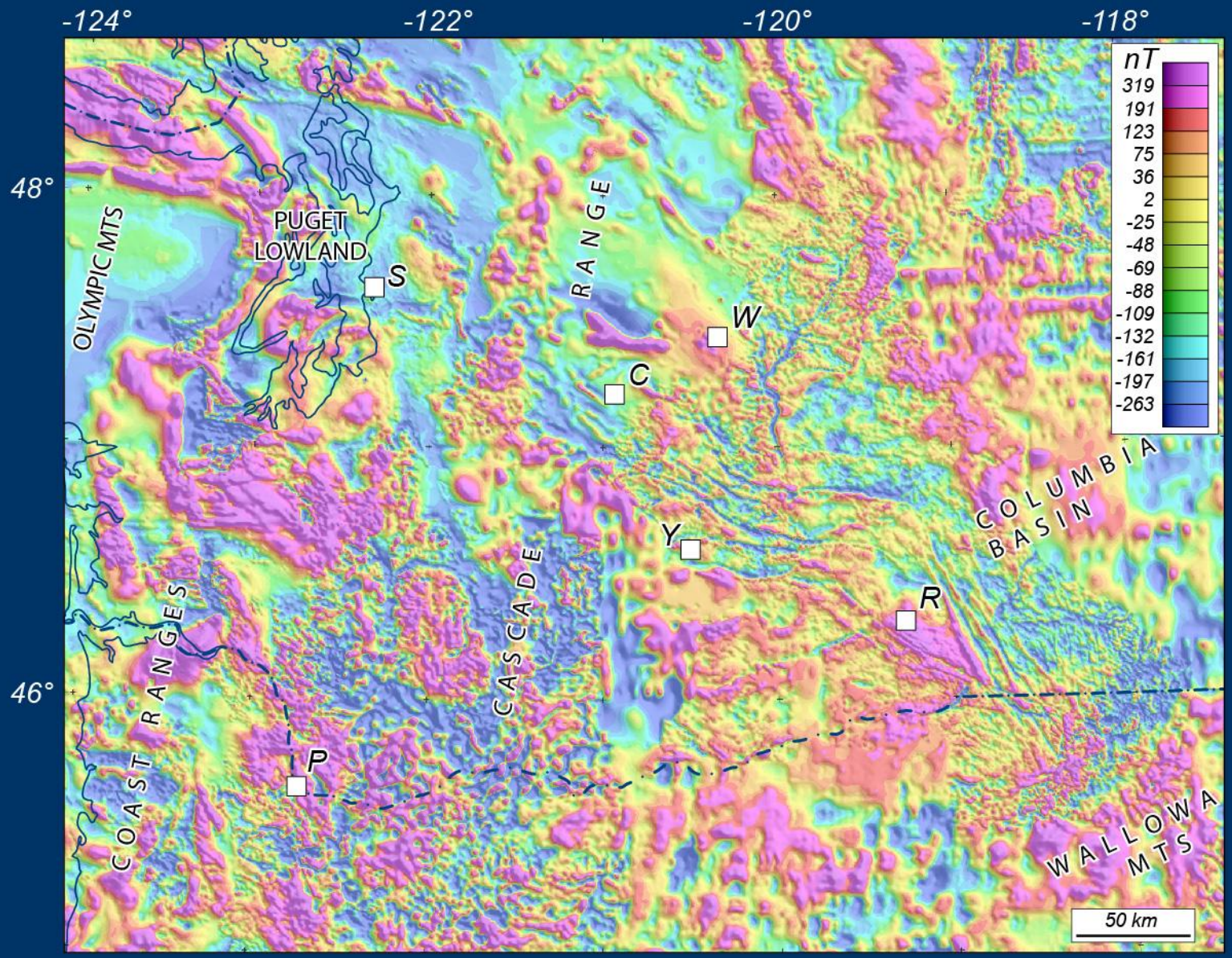
Airborne Magnetometer System

Goldak Airborne Surveys

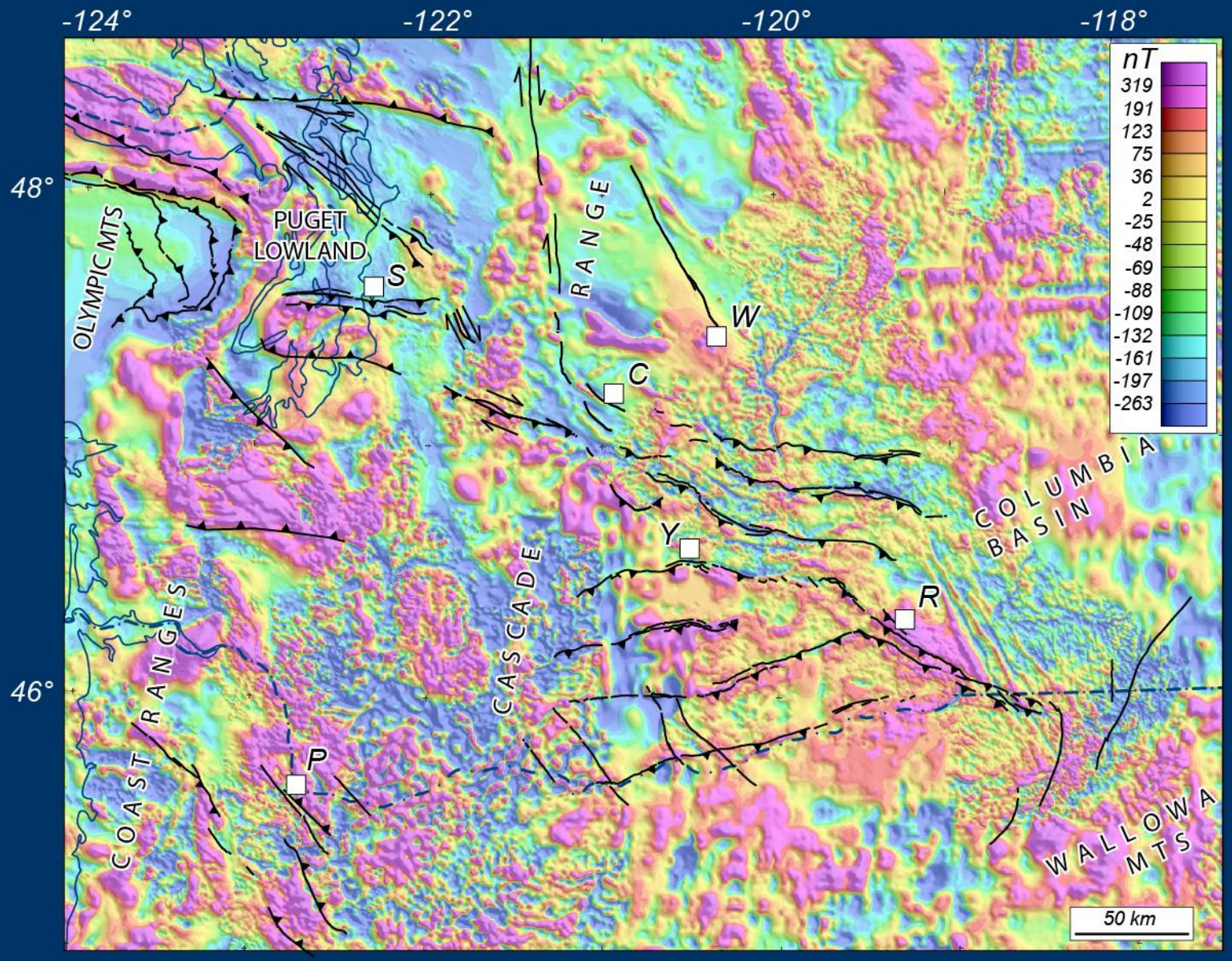

210 lb!
209.9995 lb!
R. Blakely

Gravity Measurement

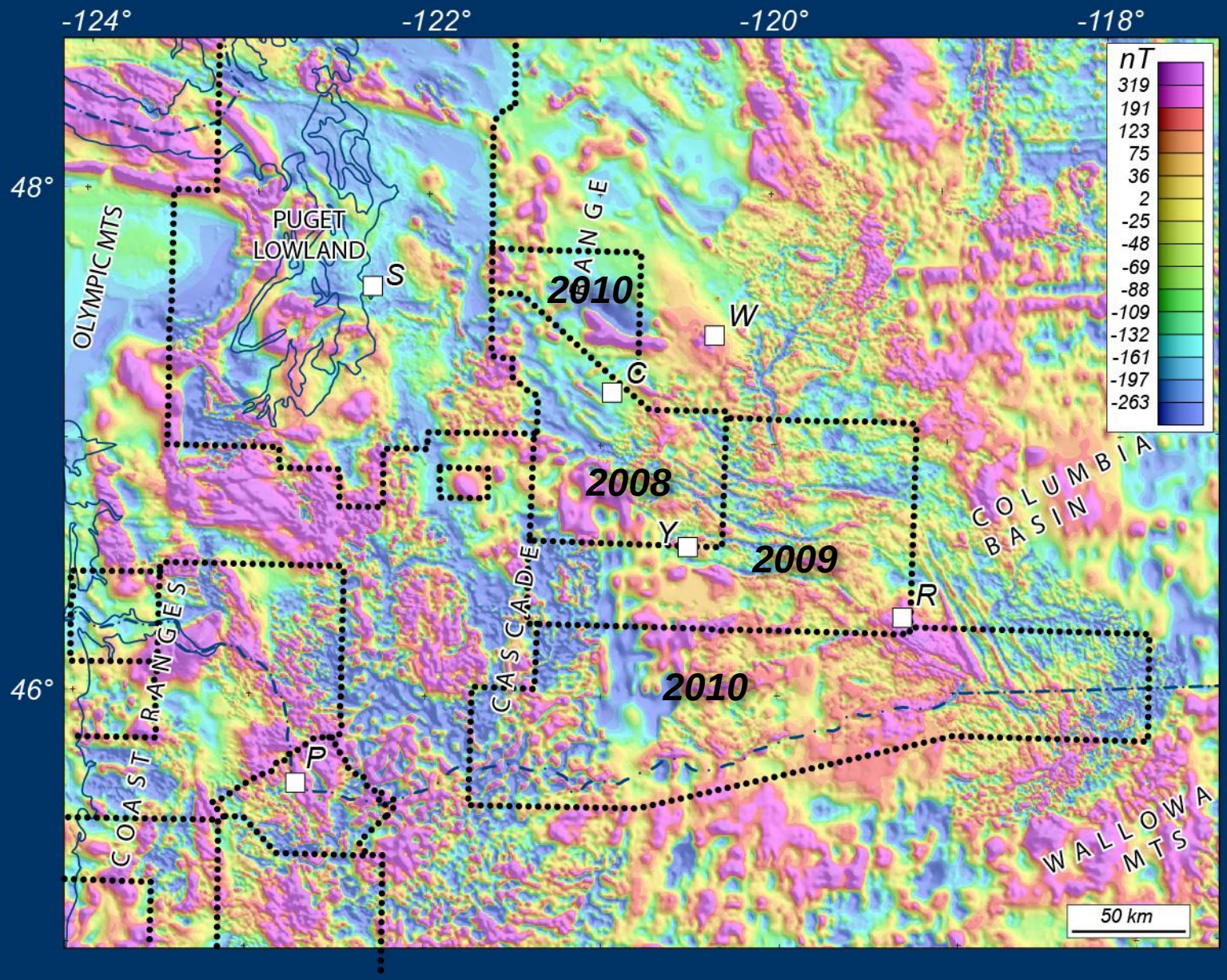
“Old” Magnetic Anomalies of Washington and Oregon



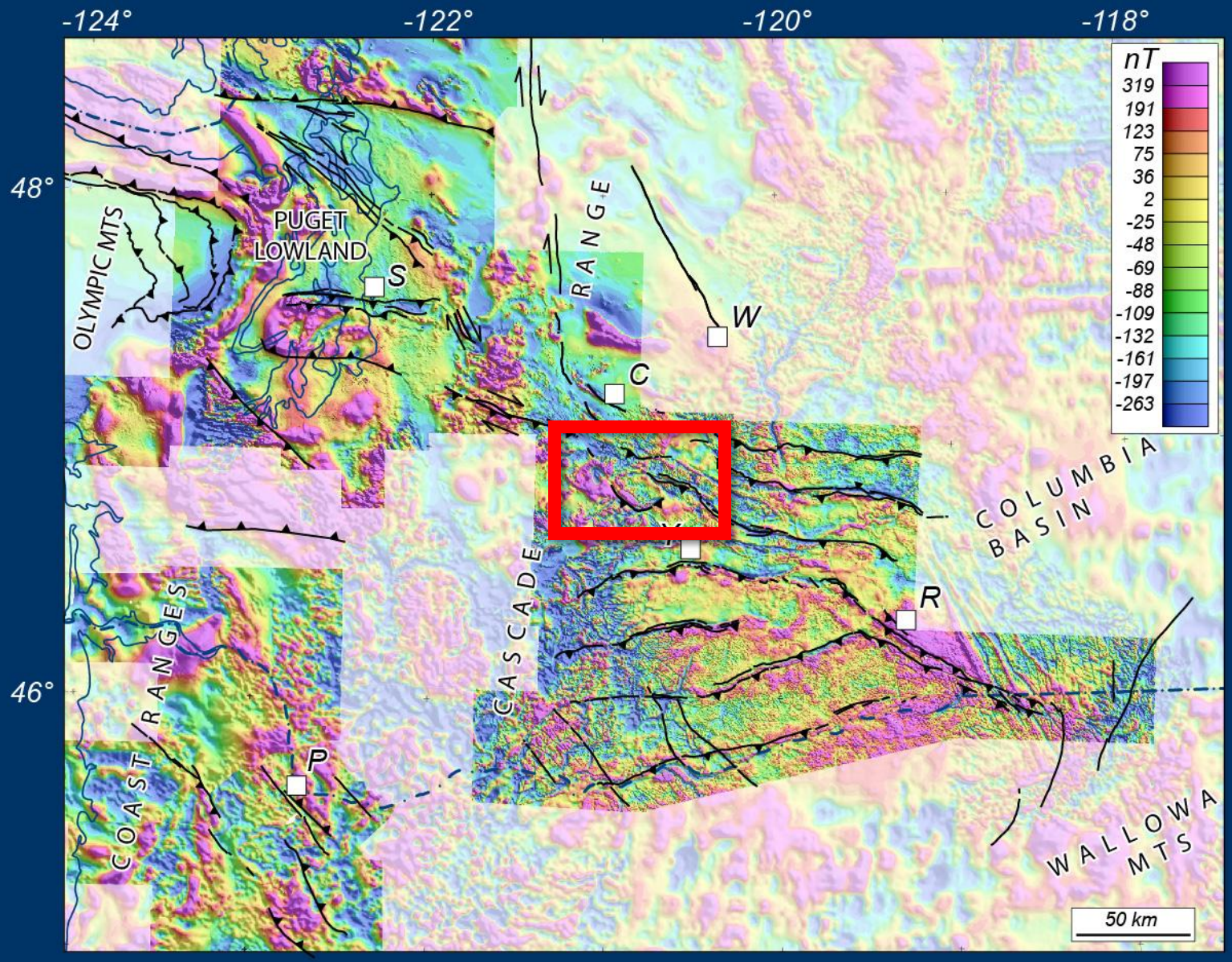
“Old” Magnetic Anomalies of Washington and Oregon



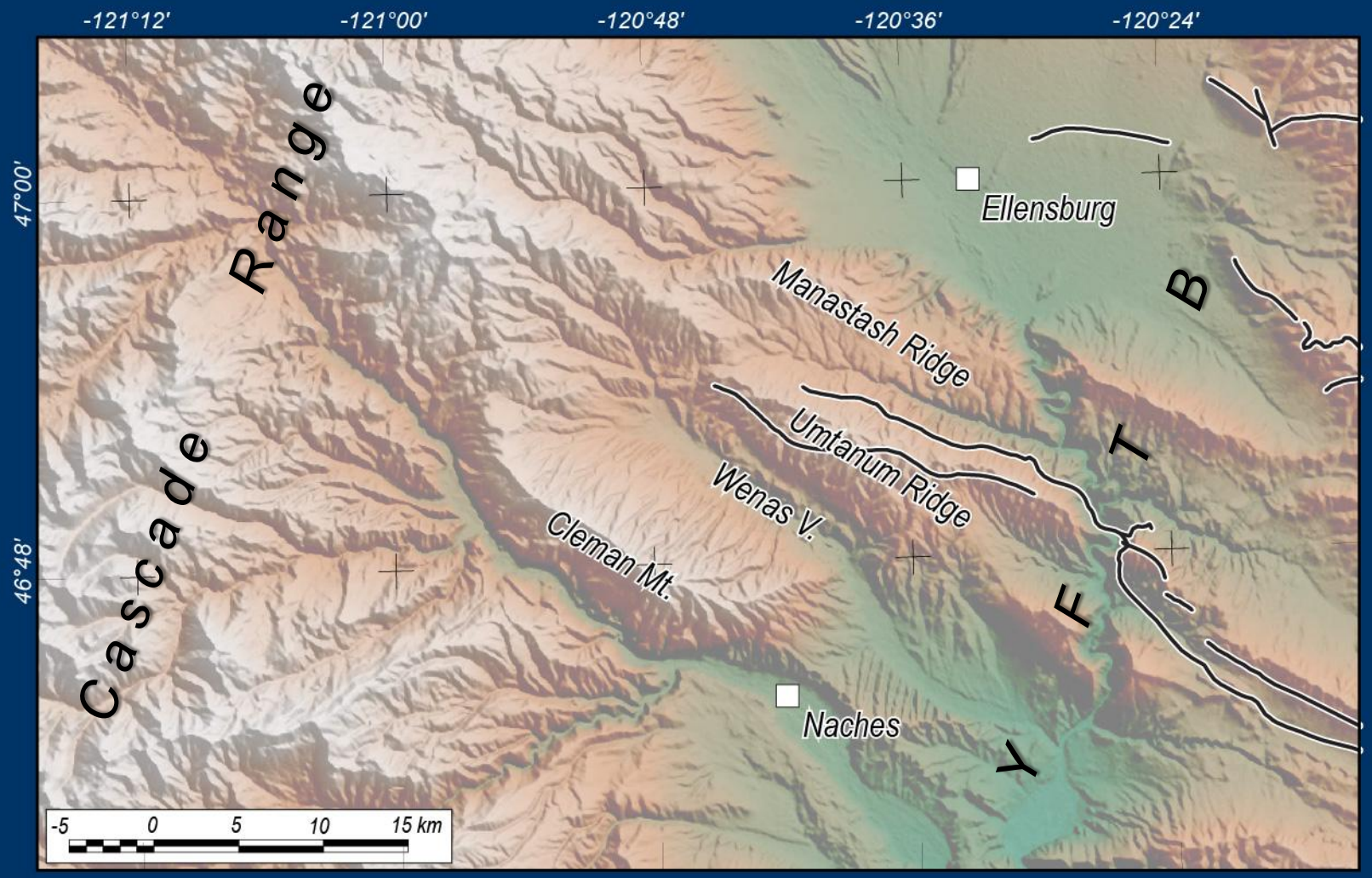
High-Resolution Magnetic Surveys



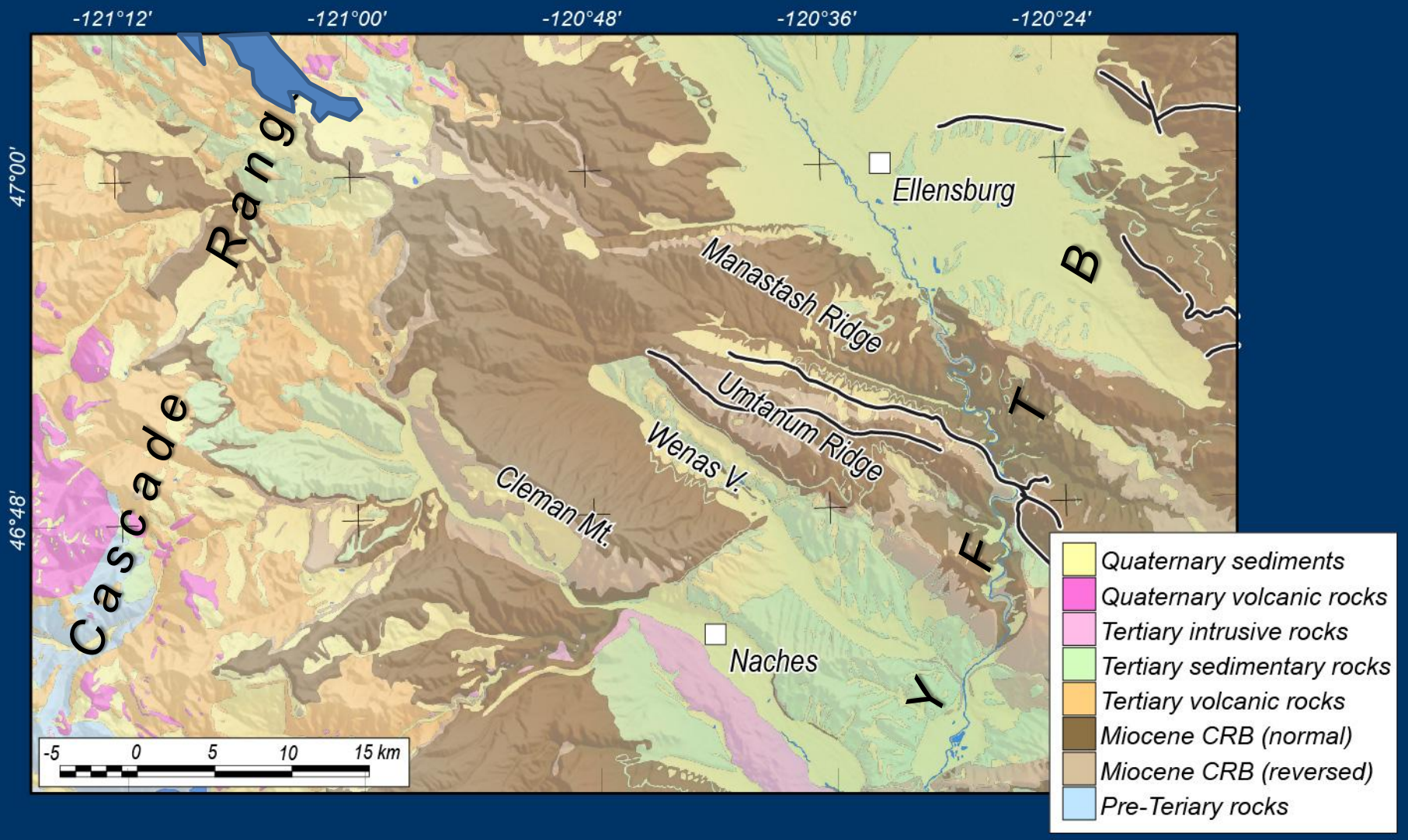
High-Resolution Magnetic Surveys



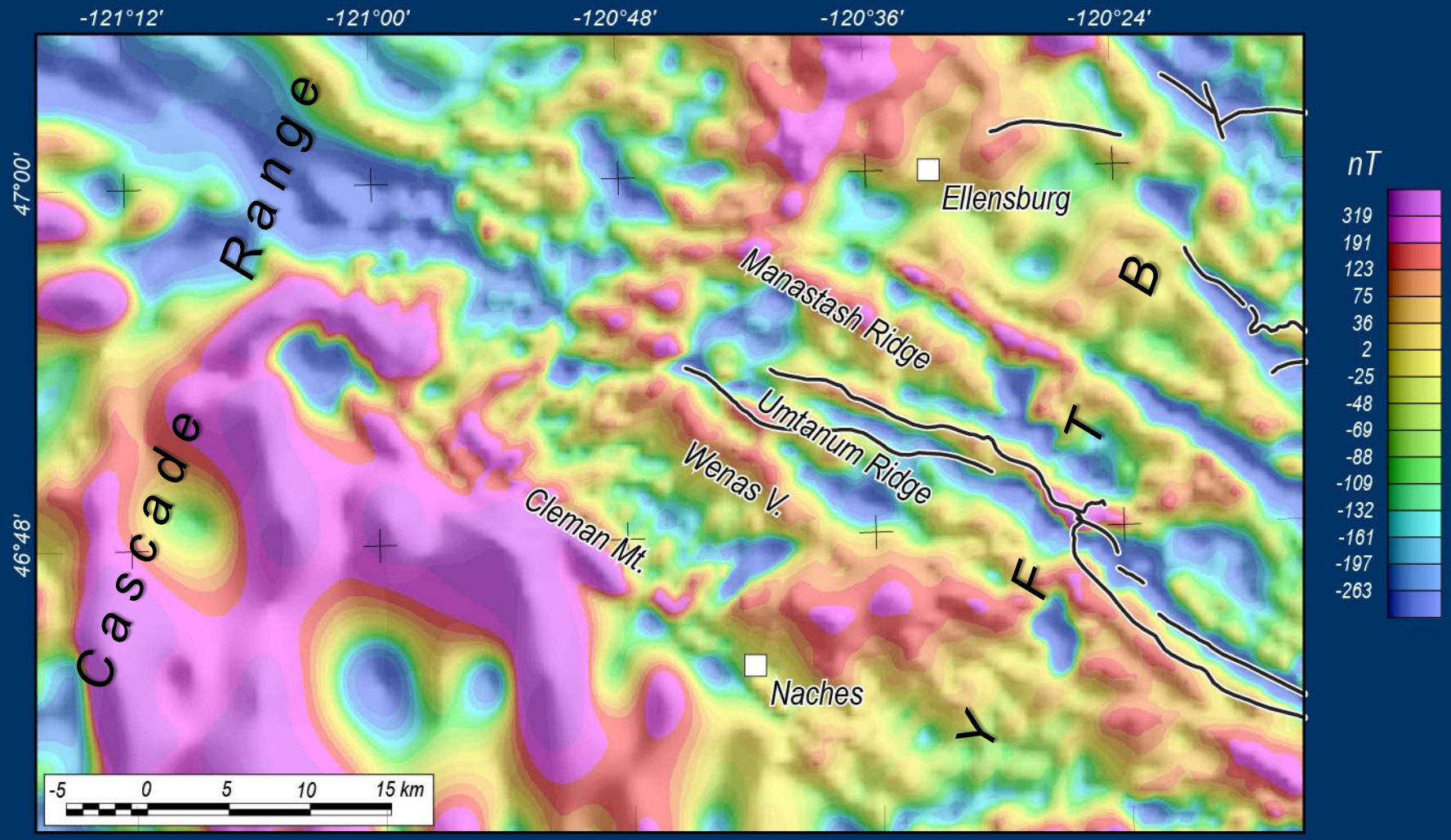
Wenas Valley and Surrounding Area



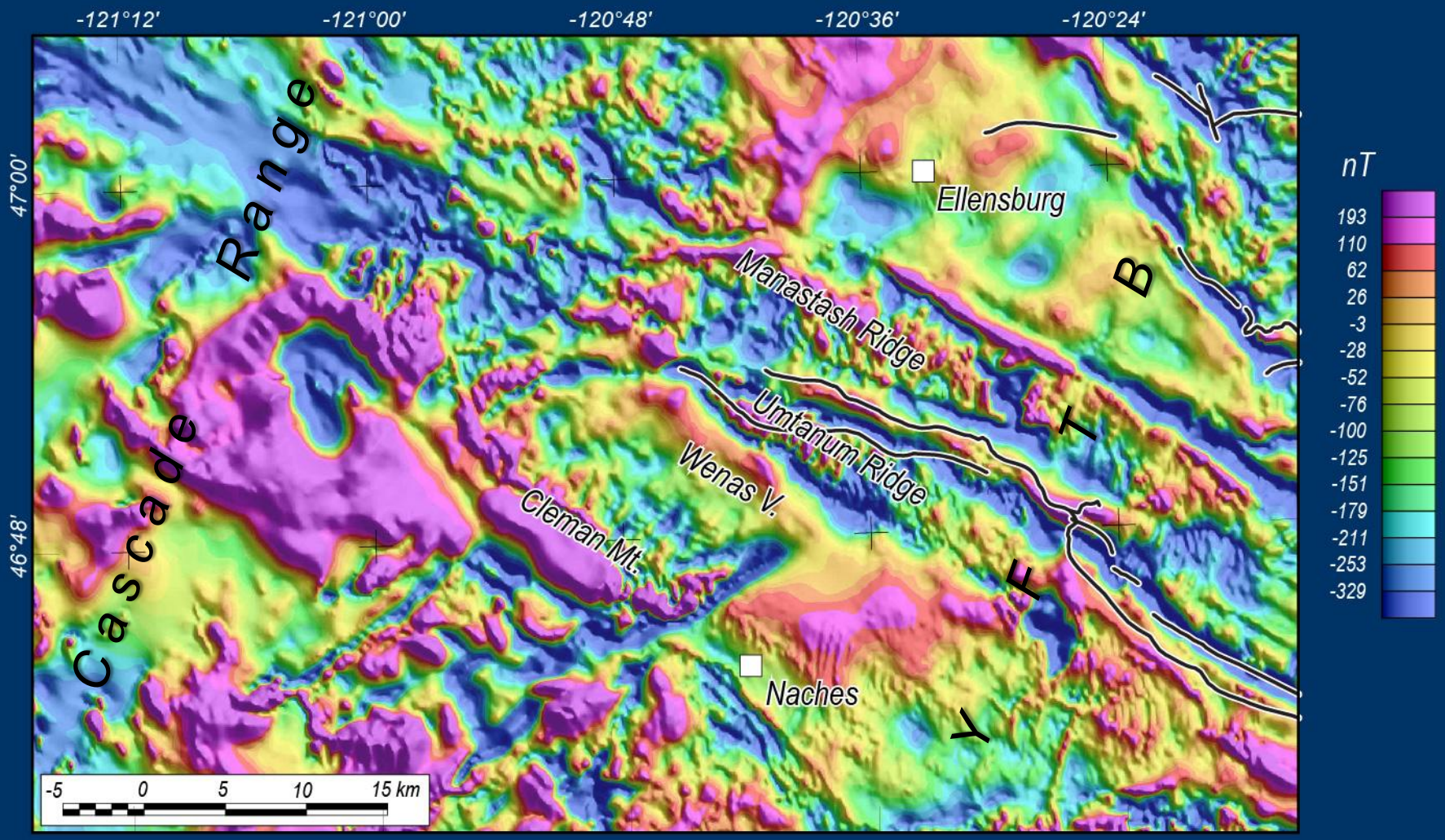
Generalized Geologic Map of Wenas Valley and Surrounding Area



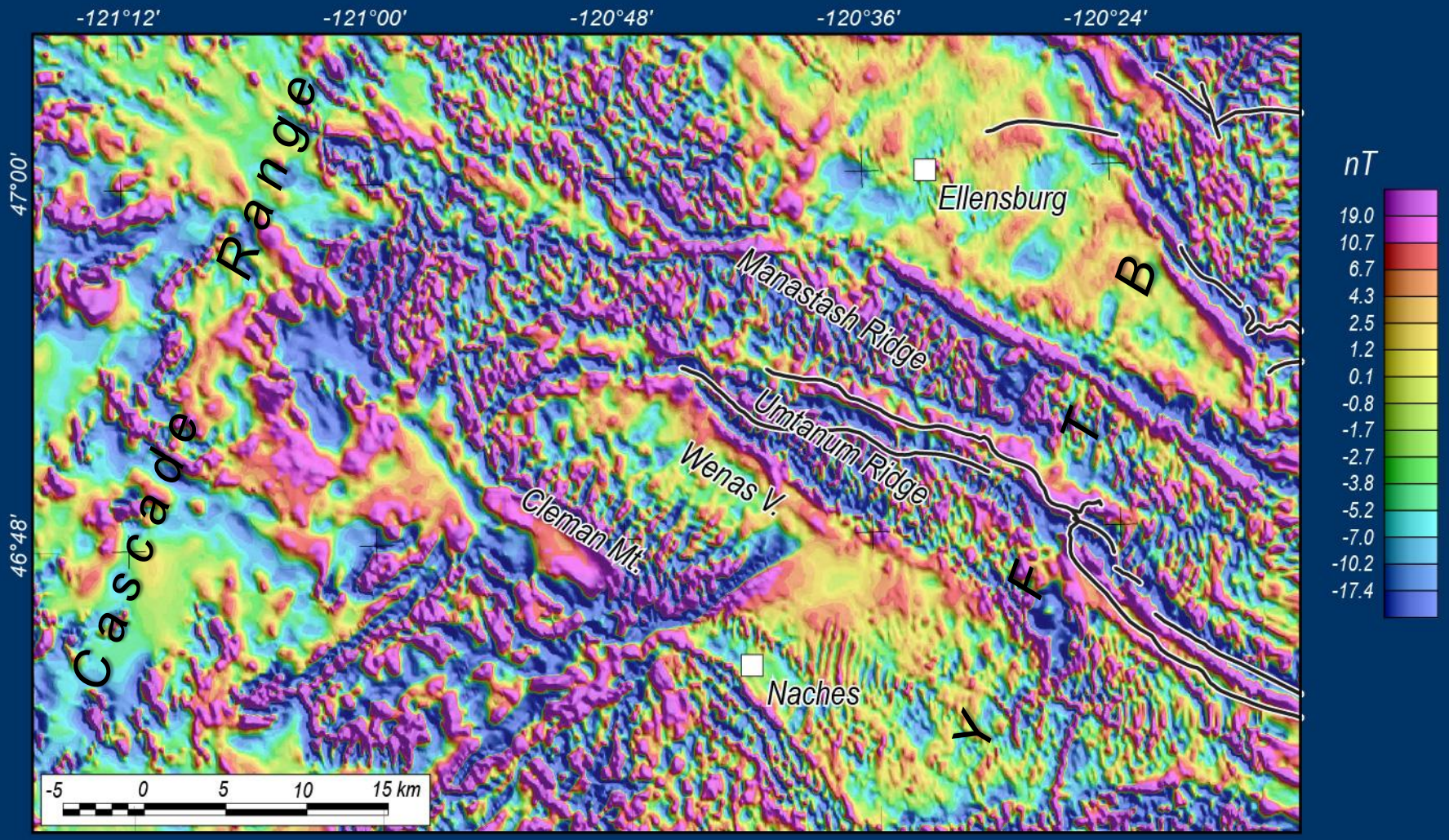
"Old" Wenas Valley Magnetic Anomalies (as known prior to 2010)



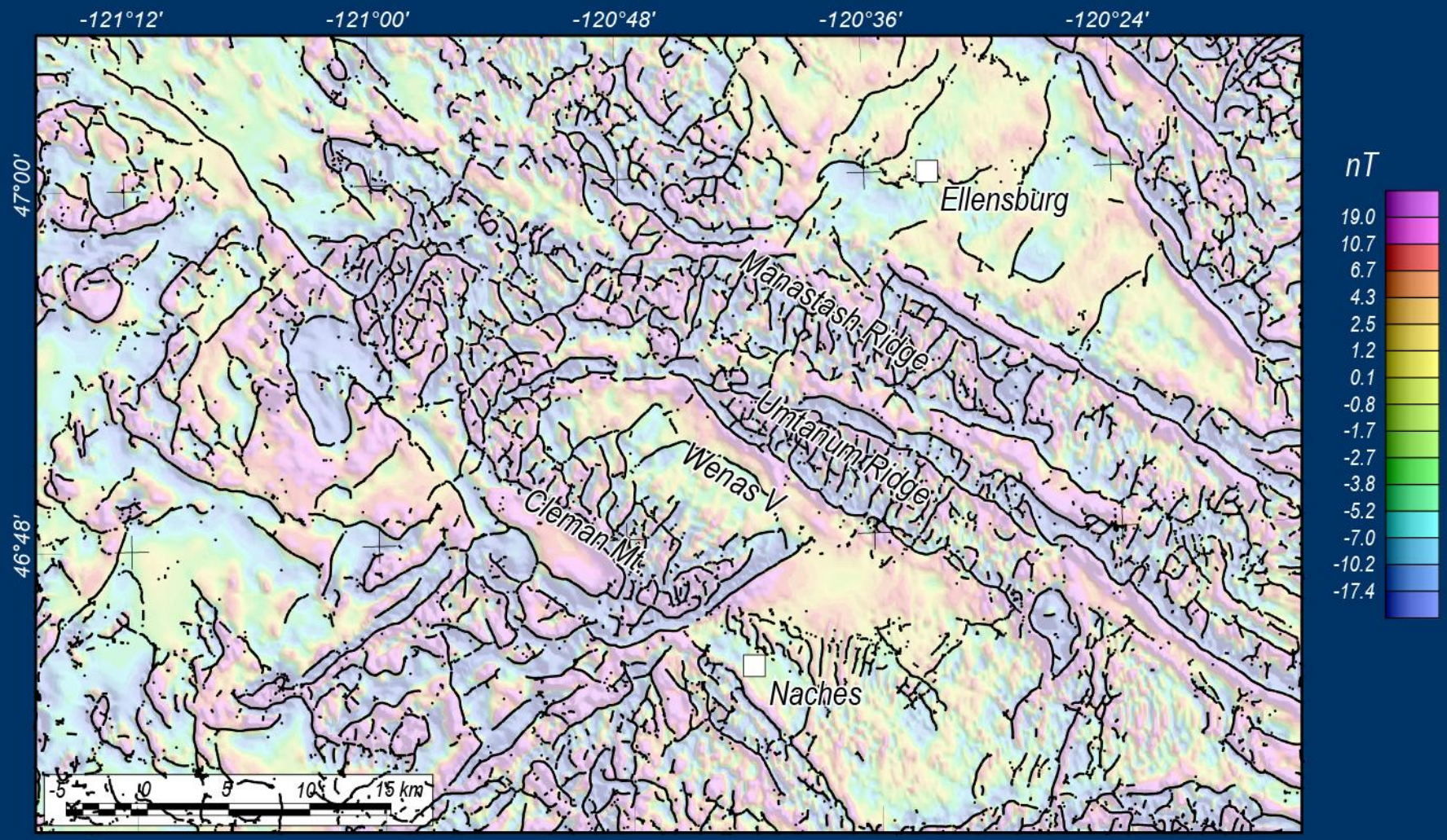
“New” Wenas Valley Magnetic Anomalies



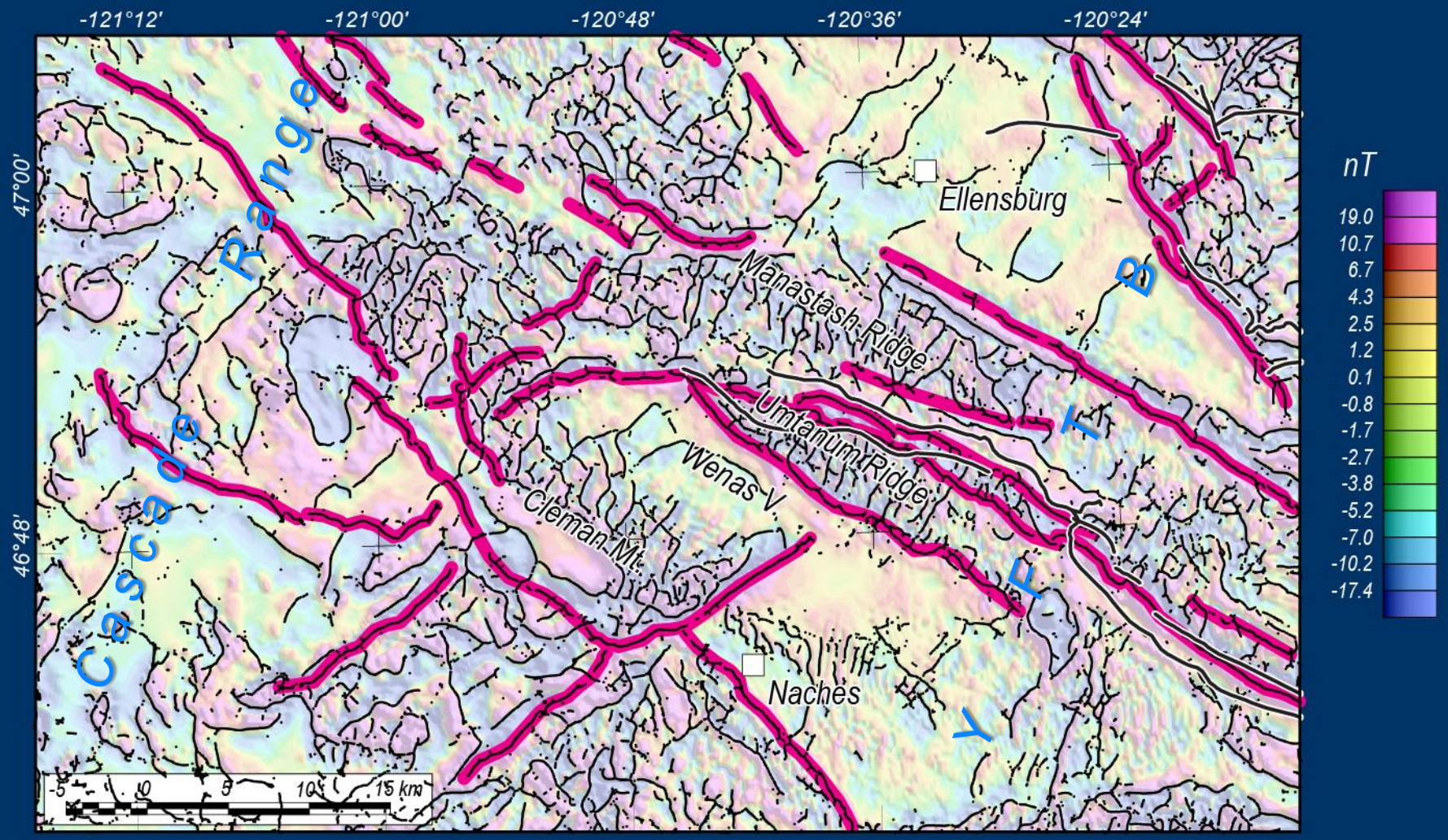
Wenas Valley Magnetic Anomalies
Filtered to Emphasize Shallow Sources



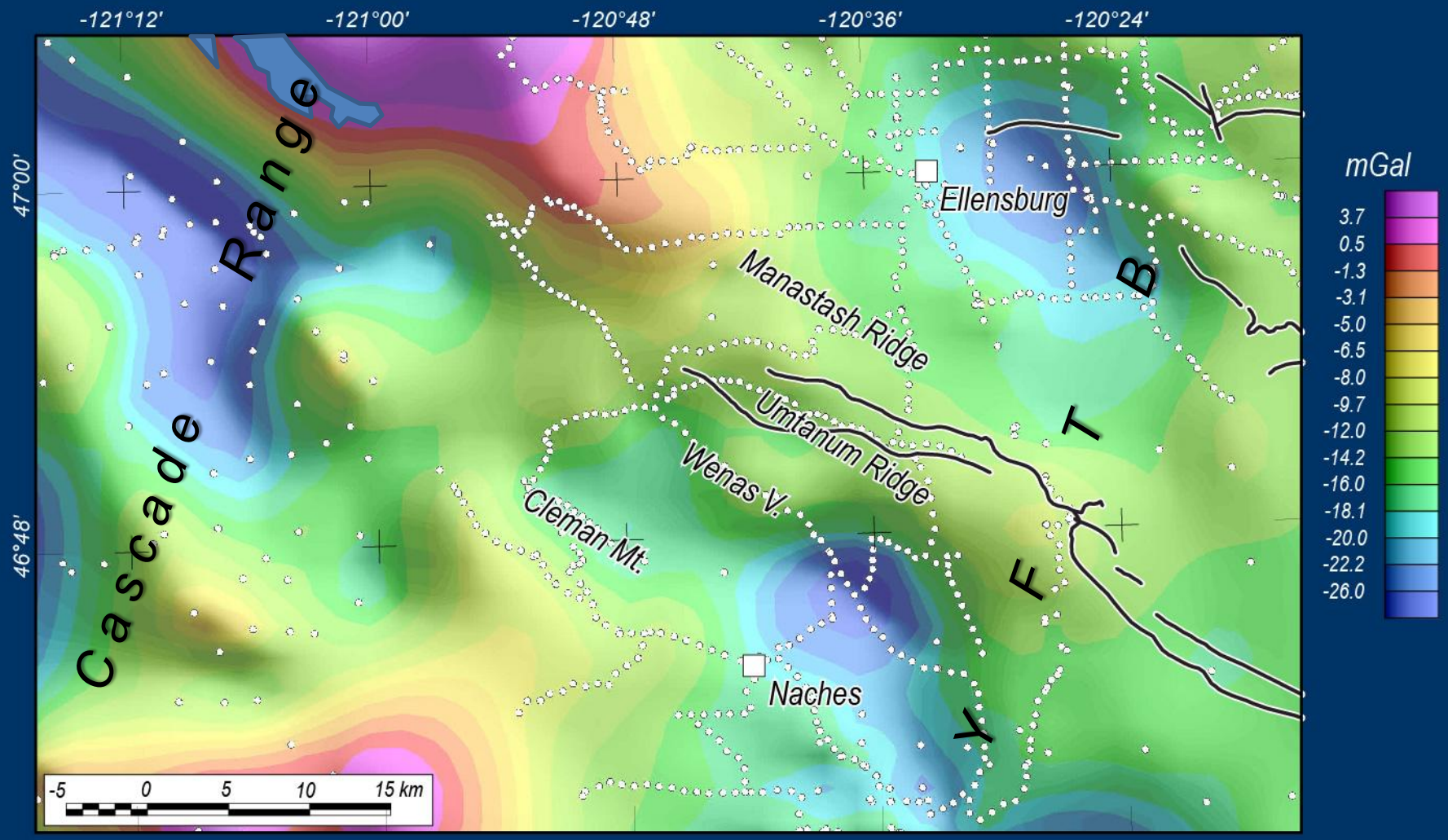
Wenas Valley Magnetic Contacts



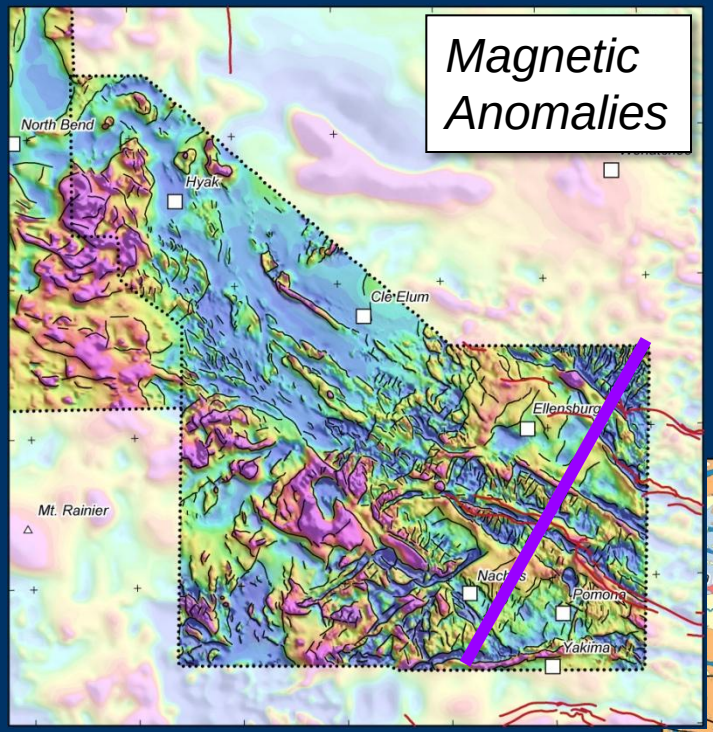
Wenas Valley, Interpretation of Important Contacts

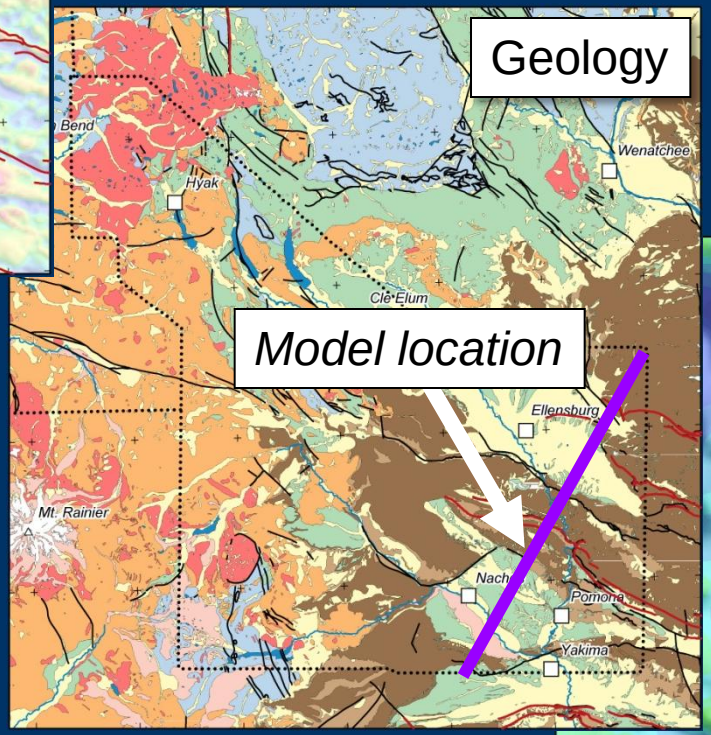


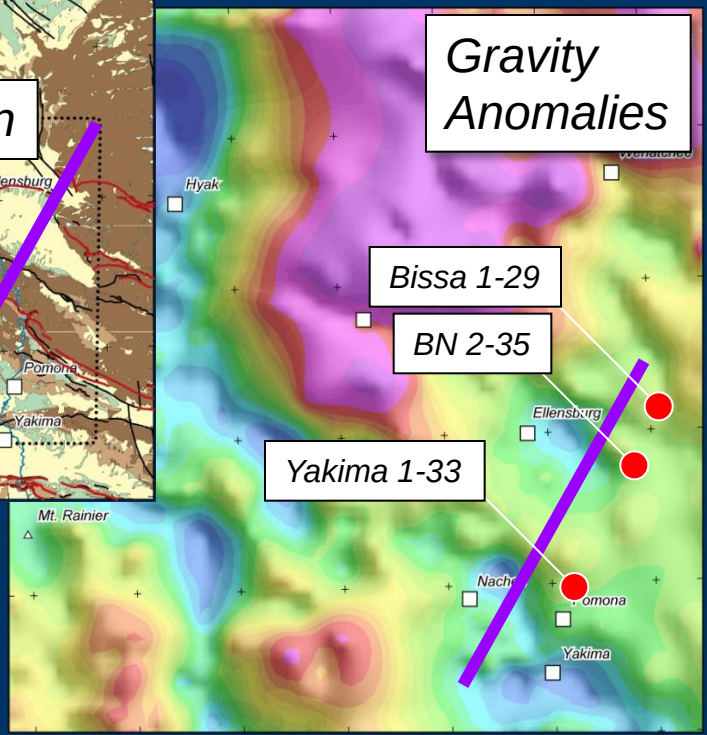
Wenas Valley, Gravity Anomalies

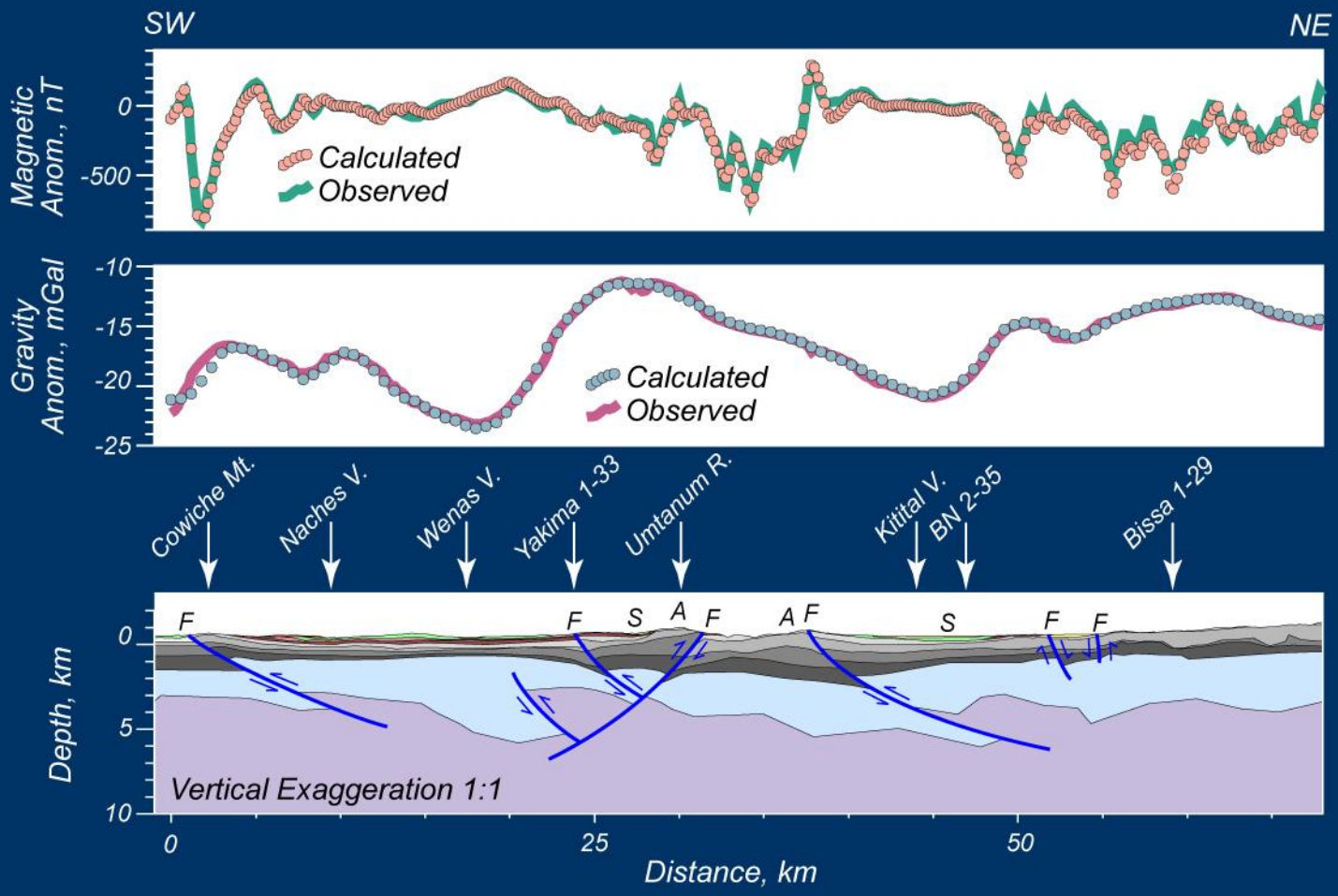


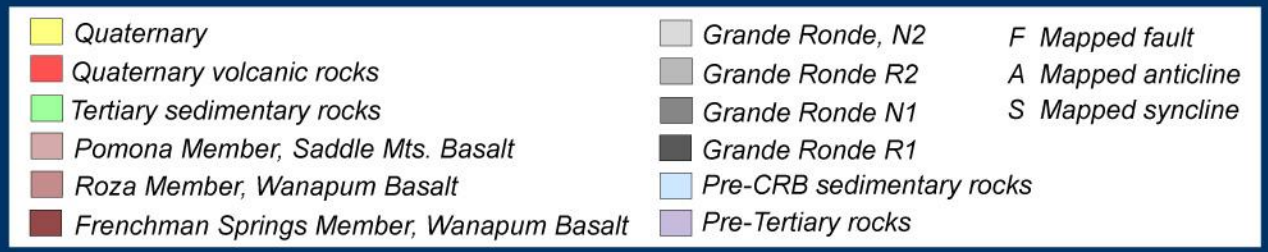
Simultaneous Gravity and Magnetic Model





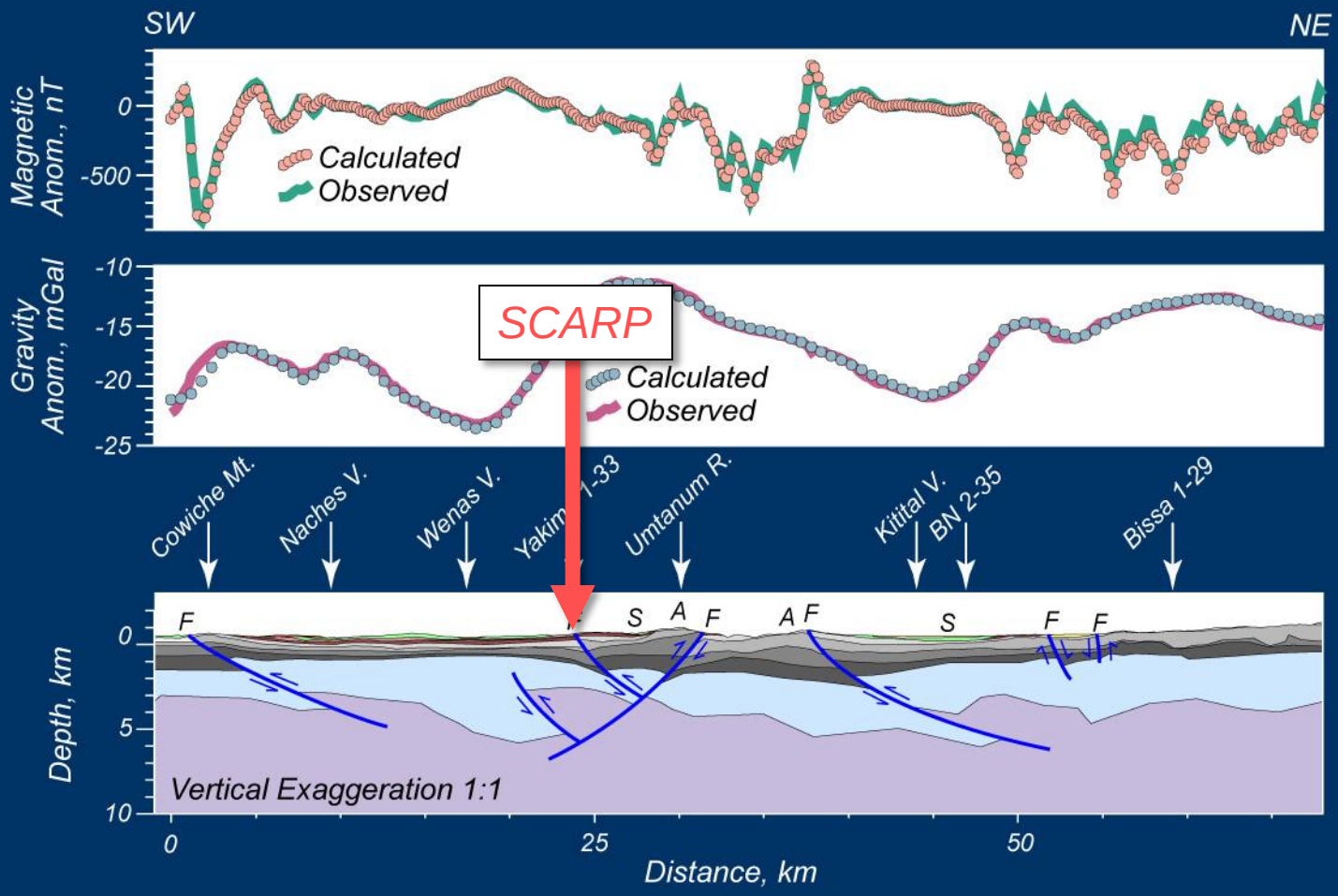






Magnetic and gravity model

No vertical exaggeration



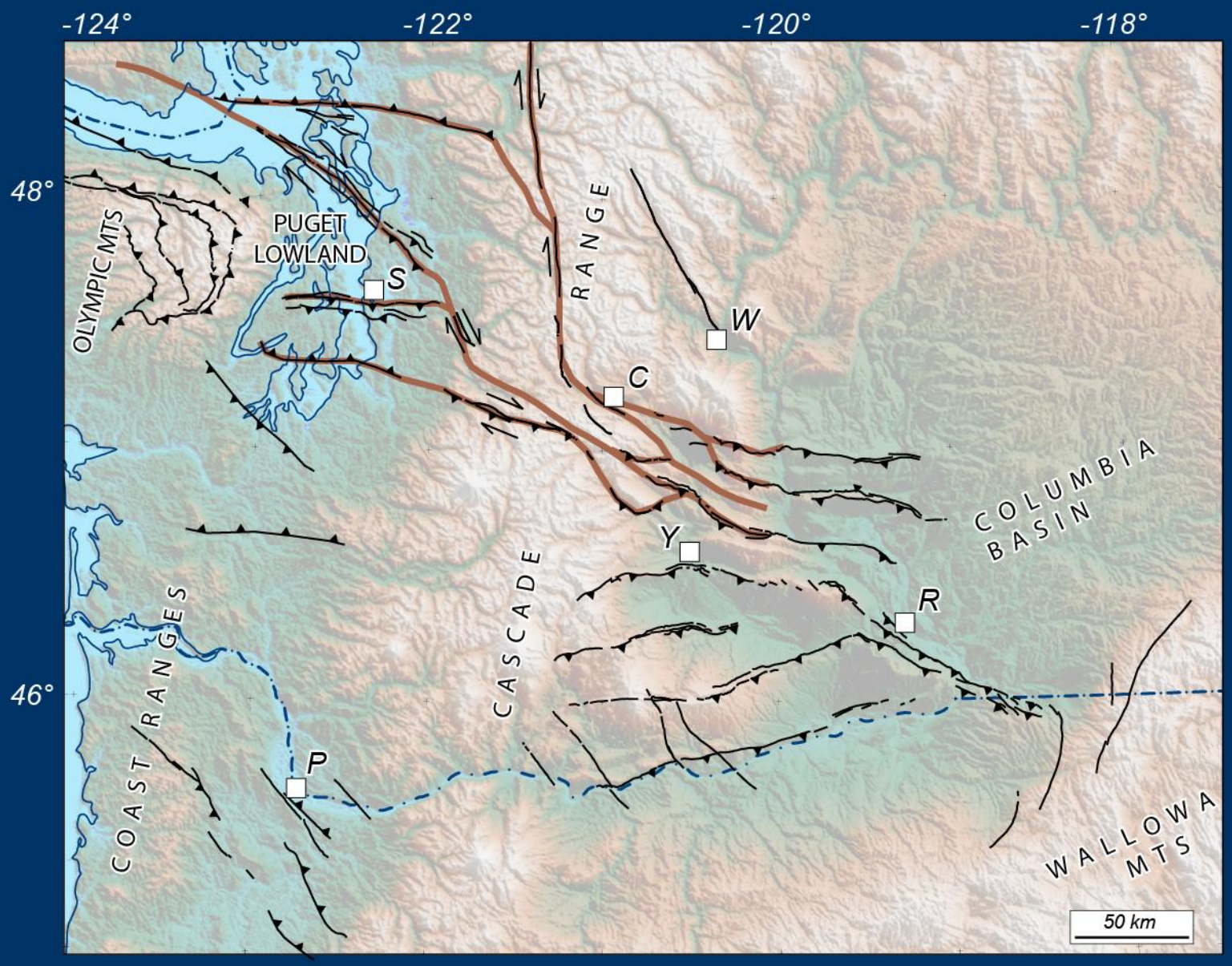
Magnetic and gravity model

No vertical exaggeration

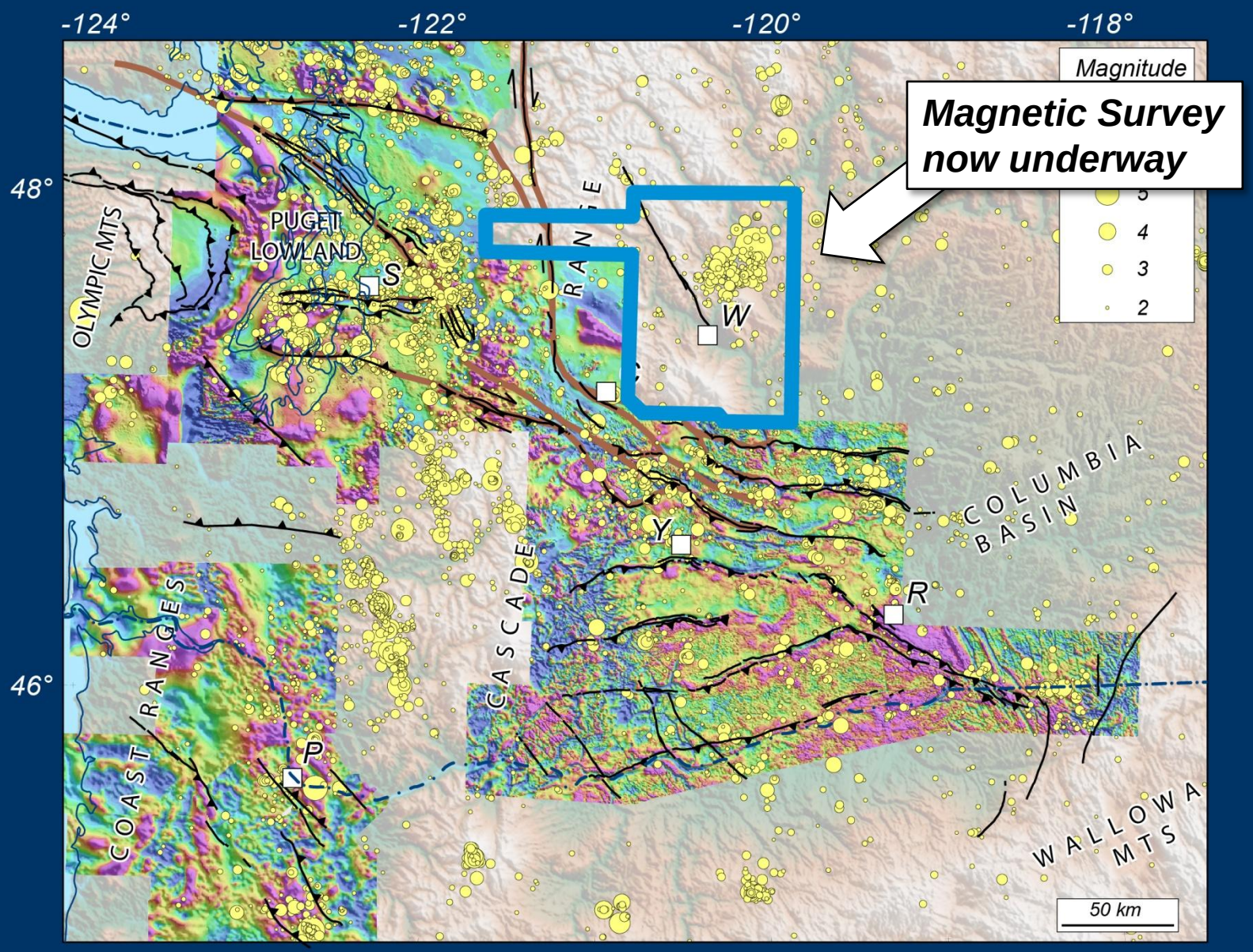
- Quaternary
- Quaternary volcanic rocks
- Tertiary sedimentary rocks
- Pomona Member, Saddle Mts. Basalt
- Roza Member, Wanapum Basalt
- Frenchman Springs Member, Wanapum Basalt
- Grande Ronde, N2
- Grande Ronde R2
- Grande Ronde N1
- Grande Ronde R1
- Pre-CRB sedimentary rocks
- Pre-Tertiary rocks

F Mapped fault
A Mapped anticline
S Mapped syncline

Interpretation of Kinematic Links, Puget Lowland to YFTB



Future Plans



Conclusions

1. *New magnetic data show the YFTB extending westward to beneath the Cascade Range.*
2. *The YFTB links through the Cascade Range to the Tacoma, Seattle, and S Whidbey Island faults.*
3. *Together these faults form a structural zone extending from central Washington to the Olympic Peninsula.*
4. *On-going paleoseismic investigations indicate that this structure is active today. The jury is still out regarding its level of seismic hazard.*